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A Preliminary Study

OF THE

Conditions for Oyster Culture

IN THE

Waters of Terrebonne Parish, Louisiana

by
L. R. Cary

ISSUED BY THE

Louisiana State Board of Agriculture
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GULF BIOLOGIC STATION

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INDEX

	<i>Page.</i>
Introduction	5
Methods	6
General Description of the Region Included in This Study.....	7
Detailed Discussion of the Conditions in the Several Bodies of Water	9
Oyster Planting in Terrebonne Parish.....	48
Spawning of the Oyster in Terrebonne Parish.....	51
Enemies of the Oyster.....	51
Conclusions and Recommendations.....	55
Utilization of Soft Bottoms.....	58
Overstocking of Small Bodies of Water.....	60
Food and Salinity Table.....	62

Introduction.

The following report is based upon a study of the physical and biological conditions of the waters of the coast of Terrebonne Parish, La. The investigations were carried on during May and June, 1906, and from March 23rd to June 30th, 1907.

This study is one of a series that is being made by the staff of The Gulf Biologic Station in the course of which it is hoped that it will be possible to cover the entire oyster-producing section of the State and thus make available to those interested in the oyster industry the facts relating to the conditions which determine the value for oyster culture in all the bodies of water on the coast of this State. The first of this series, entitled "The Conditions for Oyster Culture in the Parishes of Vermilion and Iberia, La.," was published as Bulletin No. 4 of the Gulf Biologic Station, in the spring of 1906.

In so far as possible, the results of this study have been compared with those obtained by Dr. Moore in 1898 and presented in his report on the oyster beds of Louisiana.*

Owing to the absence of any charts showing even the approximate size, location and connections of the bodies of water in the region studied, it has been very difficult to give a connected account of their relationships and impracticable to make any attempt to indicate the location of the oyster reefs, other than to refer them to the bodies of water in which they occur, giving the latter the names by which they are known to the oyster men. In this connection it may be well to mention that many of the smaller bodies of water will not be separately considered: but will be discussed along with the larger ones to which they are connected or adjacent.

Although the average salinity of the water is given in the discussion of each locality, the averages of all the determina-

* Moore, H. F.—Report on the Oyster Beds of Louisiana. Report U. S. Fish Commission for 1898, pp. 45 to 100, plates 23.

tions for many of the more important places have, for ease of reference, been gathered in the food and salinity tables appended to this report.

It is a pleasure to acknowledge my indebtedness to many of the oyster men of this region for information given, and particularly to Mr. Labat, the Deputy Oyster Inspector of this district, for many favors shown me during the course of the work.

METHODS.

The methods used in this study were the same as those used by the writer in previous investigations of the same nature, and described in detail in Bulletin No. 4 of The Gulf Biologic Station, except that in making the soundings it was impossible to get any definite bearings in the absence of any chart of the smaller bodies of **water**.

GENERAL DESCRIPTION OF THE REGION INCLUDED IN THIS STUDY.

The area included within the limits of this investigation extends from Atehafalaya Bay on the west, up to and including the western part of Timbalier Bay on the east. Within this area there are two large open bodies of water—Pelto Lake and Cat Island Lake (Terrebonne Bay of the government charts). These are separated from the Gulf of Mexico by a chain of narrow islands, between which there are several passes affording a ready access for the saline waters of the Gulf. Farther inland the bodies of water are smaller, and consist of bays and bayous, cutting up the low-lying marsh into innumerable islands, which vary from one to several acres in extent.

Over all of the region north of the larger lakes the water covers a considerably larger area than the land, which consists entirely of marsh usually only a few inches above the water, or even overflowed at ordinary high tides. In some few instances there are found, along the bayous, or on the outer sides of the islands to the west of Bayou Caramboque, banks some few feet above the surrounding marsh, and many of these places have been utilized by the oyster men as locations for the camps in which they live during the summer to watch their leases.

The bayous are in most cases rather deep and narrow, with mud flats along one or both sides, and frequently with shallow reefs of oysters or dead shell in the channel. Practically all of them have their greatest depth near the mouth, and in no instance is there a well-defined bar at the outlet.

The lakes and bays are shallow bodies of water, usually with a level floor composed of soft mud, except where there is or has been an oyster reef. In some of the larger bays, in the western part of the parish, there is a well-defined channel, on one side of the bay, where the water is much deeper than over the other parts, affording a passage for good-sized boats.

Throughout the region under consideration, but especially in the part East of Lake Pelto, there are rapid and extensive

changes taking place in the topography. In the section between Cat Island Lake and Timbalier Bay there are islands in all stages of disintegration: some of them are barely above the surface of the water, while the former location of others is marked by the tops of the dead grass and bushes which alone extend above the water. Farther inland there has been a very noticeable increase in the area of many of the lakes, and some of them are several times as large as they were fifteen or twenty years ago. The making of artificial cuts has, in some instances, changed the drainage so that former deep places have become filled up and the oyster reefs covered, while other localities become better fitted for the growth of oysters, and whenever any clutch is available a new reef is started.

The inland bodies of water may be separated into three divisions in respect to the salinity of the water. In all of the bays, lakes and bayous to the west of Grand Pass des Isles the salinity of the water is directly affected by the flow of fresh water from the Atchafalaya River through Four League Bay and Blue Hammock Bayou. These bodies of water receive also the discharge from Bayou Grand Caillou and from Little Bayou du Large. In times when the Atchafalaya River is high there is a noticeable lowering of the salinity in all of these bodies of water, while at any time the water is less saline than in those farther to the eastward. In the second division, between Grand Pass des Isles and Cat Island Lake, there is very little drainage from the upland and the water in the bays and bayous is of practically the same salinity as that in Lake Pelto. In the section to the east of Lake Pelto the fresh water from Bayou Little Caillou and Bayou Terrebonne is discharged, and here the water is less saline than in the section above Lake Pelto; although, except in times of very severe freshets, the salinity is not so low as in the bodies of water to the west of Grand Pass des Isles.

Over all of the territory included in this study the tidal currents are very strong, and are not so much influenced by the wind as they are farther to the westward along the coast. In some of the larger bayous the currents run from two to four miles an hour under normal weather conditions; while in severe storms from the South the velocity of the current may

reach six miles or more. Even in the shallow bays, where there are practically no inequalities on the bottom, the current seldom falls below one mile an hour and is usually considerably greater.

DETAILED DISCUSSION OF THE CONDITIONS IN THE SEVERAL BODIES OF WATER.

In the consideration of the different localities it has seemed best to take them up as nearly as possible in the order of their occurrence, starting with Four League Bay on the western side of the parish.

FOUR LEAGUE BAY AND OYSTER BAYOU.

In *Four League Bay* the oyster reefs are all situated in the lower southern end of the bay. All of the oysters on these reefs are small and of very poor quality. The bottom surrounding the reefs is composed of very soft mud, incapable of supporting oysters without artificial hardening. The water in this bay is, almost always, nearly fresh, owing to the discharge of the water from the Atchafalaya River. The food supply is at best very unstable, and there can be no assurance of success from any plant in this bay. In *Oyster Bayou*—the connection between Four League Bay and the Gulf of Mexico—which is some two miles long and from 100 to 150 yards wide, the salinity of the water is also very variable. The depth of the water in this bayou varies from eighteen feet to not more than six feet at the mouth, while in the middle portion of the bayou there are oyster reefs in the channel that are exposed at low tide. The oysters from the reefs in this bayou, both the deep-water reefs as well as those along the banks, are elongated and of very poor quality. During the past winter a great many seed oysters were taken from the deeper reefs in this bayou; but all of them were old “coony” oysters that would never show any marked improvement in size or shape. The food supply is very variable, depending on the condition of the water in the bay above; and while at times it is as abundant as on any of the reefs near by, there is no certainty that there will be an abundance of food at the time when the oysters should be in condition for the market.

HELL HOLE BAY AND BAYOUS.

The first bodies of water of any importance to the eastward of Four League Bay are those known to the oyster men as *Big and Little Hell Hole Bayous*, *Hell Hole Bay*, and *Little* (or second) *Hell Hole Bay*, and *Bay Castagnet*. All these are included in the area of marsh bounded by Four League Bay on the west, Blue Hammock Bayou on the north, and Bay Junup on the east. These bays have open communication with the Gulf by small bayous; but there are no connections with the bodies of water to the eastward. There are no oyster reefs of any importance in these bodies of water; but some small reefs of eoon oysters furnish a good part of the seed that is used in making the plants there. The water is usually more saline than in the larger bays in this section of the parish, as there is no direct connection with Four League Bay and thus with the fresh water from the Atchafalaya River. The bottom is very soft, both in the bays and bayous, except where there is or has been a reef of oysters. The food supply was abundant at the times when determinations were made in April and June, 1907.

Bay Junup, situated some seven miles east from Oyster Bayou, is about five miles long and has a maximum width of from one and one-half to two miles. At its south end there is a communication with the Gulf through Bayou du West, which is about one mile long and one-quarter of a mile wide. From the entrance to Bayou du West there is a narrow channel that runs along the east side of the bay for its entire length, having about ten feet of water in the shallowest places. The water is very shallow, from two to four feet, over all the western part of the bay, except near the entrance to some small bayous on the west side, and, during low tides in winter, the crests of a great many of the reefs are exposed. Practically the whole of the shallow western part of the bay is covered with scattered reefs, most of them of small extent with patches of very deep soft mud between. The oysters making up the most of these reefs are small, densely crowded, and of very poor quality, so that they are not suitable for the market. On some of the reefs in the northwestern part of the bay there are, however, some good marketable oysters, and on the deep reefs in the channel at the entrance to Buckskin Bay there are good-sized oysters; but

these are in such deep water that they cannot be taken profitably with tongs. The salinity of the water in this bay is usually quite low—1.0089 in March, 1907—and in times when the Atchafalaya River is high the water on the surface becomes absolutely fresh, as was the case for several days in April, 1907. The food material in the water is, under stable conditions of salinity, fairly abundant; but the supply, in the spring at least, is uncertain, depending to a great extent on the condition of the water.

A great many oysters are taken from the reefs in this bay to be banked on leased bottoms in some of the neighboring bodies of water, and a few bedding grounds have been taken up in the southwestern part of the bay.

In *Buckskin Bay*, immediately north of Bay Junup, there are several reefs in the southern part of the bay and one large reef in the central portion, while in the northern part the bottom is mostly barren. The depth of water varies from eighteen feet near the entrance of the channel from Bay Junup, to five or six feet, which is the general depth over the greater part of the level floor of the bay. At the northern extremity of the bay there is a wide pass into Blue Hammock Bayou, so that the water in this bay varies very much in salinity, and is usually too fresh to insure the well-being of the natural reefs, or to justify any one in making artificial beds.

In *Blue Hammock Bayou*, between Buckskin Bay and Four League Bay, there are many places where the bottom is covered with a continuous layer of shells, and several of the oyster men who have fished in this region in years past report having taken good oysters from these reefs. Several times within the past ten years there has been a set of spat in this bayou, but the young oysters have been used for seed, and, so far as could be determined, none of those left in the bayou have lived to produce marketable oysters.

In the springs of 1906 and 1907 when this bayou was visited, the water was either absolutely fresh or too nearly fresh—1.0028 in June, 1907—to permit of the growth of oysters, so that it would appear that when a set of spat occurs here the only way to save any of them is to take the young ones for

seed as soon as they have reached a size when they can withstand the hardships attendant upon being taken up and rebedded.

East Bay Junup, or *Little Bay Junup*, situated immediately to the eastward from the southern part of Bay Junup, communicates with the Gulf through Bayou du West which empties in the latter bay. On its east side there is an opening to Taylor's Bayou, and at the northern extremity a small bayou connects with the lower end of Mud Hole Bayou. This bay is about one mile in diameter, being roughly circular in outline. There is a channel along the western side for its entire length. The water over the southern part of the bay is from one to three feet deep, while in the northern part it is from six to ten feet. The greater part of the bottom is covered with reefs, many of which are exposed at ordinary low tides. The oysters making up the shallow reefs are all densely crowded; while on some of the reefs in the deeper parts of the bay good oysters are found quite abundantly. The bottom between the reefs in the shallow part of the bay is composed entirely of soft mud, in most places incapable of supporting seed oysters. In the northern part of the bay and in the channel where the deposition of sediment is not so rapid, the bottom is firmer and in many places could be utilized for planting without any preparation.

The water in this bay is always more saline than in West Bay Junup, and is not so quickly affected by the flow of fresh water from the westward. The amount of food materials in the water is fairly large, and the poor condition of the oysters on the crowded reefs is to be attributed to the crowding of the oysters and not to the inadequacy of the food supply.

Taylor's Bayou has its mouth just East of Little Bay Junup, about one-half of a mile from the mouth of Bayou du West. This bayou runs north for about two miles, then in an easterly direction for about the same distance, where it opens into the southwest corner of King Lake. The bayou is some 200 yards wide throughout the greater part of its length, and there are more or less extensive mud flats on either side of the channel. The depth of water varies from fifteen to thirty feet in the lower part of the bayou, while in the upper end, about one mile from King Lake, there is a reef in the middle of the bayou covered by about four feet of water at low tide. The

bottom is firm, except on the mud flats, on either side of the channel.

The salinity of the water is very stable, being between 1.0100 and 1.013 even when the water in some of the neighboring bays was absolutely fresh during the freshets of April, 1907. The food supply is abundant and very stable.

There is a scattering growth of coon oysters all along the banks, for the greater part of the length of the bayou, and in a few instances the reefs extend for a considerable distance toward the middle of the bayou.

MUD HOLE BAYOU AND MUD HOLE BAY.

Mud Hole Bayou empties into Taylor's Bayou at the point where the latter makes the abrupt bend to the eastward. It is about two miles in length, and comes from the southwestern part of Mud Hole Bay. Near its lower end there is a pass into Bay Junup. The depth of the water in this bayou is very irregular, being only about two feet over some of the reefs in the lower part of the bayou; while a short distance above this point there are reefs in fifteen feet of water. The bottom is rather soft outside of the areas occupied by living or extinct reefs.

The water is less saline than in Taylor's Bayou, being influenced by the flow through the pass from Bay Junup. The food supply is usually abundant, but rather unstable. The oysters on the reefs in the lower part of the bayou are of rather poor quality and are used mostly for bedding.

Mud Hole Bay is a body of water composed of two arms: one of which runs north for about one mile from the entrance to Mud Hole Bayou, the other nearly east for some two miles. The western arm of this bay is separated from Buckskin Bay and Bay Junup by a narrow strip of marsh scarcely fifty yards wide. At the eastern end there is a cut connecting this bay with King Lake. There is about three feet of water over all the bay, and the bottom is made up of rather soft mud with some finely broken shell mixed with it.

The salinity of the water varied from 1.008 to 1.012 at different times between March and July, 1907, but it was always

within the limits suitable for the growth of oysters. The amount of food material in the water was very large every time that an examination was made, and the oysters on private bedding grounds were in very good condition for the season.

In the area included between Taylor's Bayou on the south, Mud Hole Bayou on the west, Mud Hole Bay on the north and King Lake on the East, there is a large shallow bay known to the oyster men as *Banana Bay*. This bay communicates with Taylor's Bayou by a broad, shallow pass and with the western part of King Lake by a narrow bayou—*Banana Bayou*. In this last-mentioned bayou there are some good oysters in about fifteen feet of water; but the reefs reported by Dr. Moore in 1898 as being productive, are now so thoroughly depleted that they are no longer fished. There are scattering bunches of coon oysters all along the banks of the bayou. In *Banana Bay* the water is from one to three feet deep, and there are reefs of coon oysters scattered over the eastern part. Over the greater part of the western half of this bay the bottom is composed of very soft mud and there are very few reefs. The salinity of the water in this bay is about 1.010, and is quite constant. The food plants are abundant and the supply is very stable, as was shown by several determinations made under varying conditions during the past spring.

King Lake, at the head of Taylor's Bayou, is about two miles long—north and south—and varies in width from one to one and one-half miles. The depth of the water in this lake varies from two and one-half to five feet, being greatest near the entrance to Taylor's Bayou. There are no productive natural reefs in this lake at the present time; but there are several old reefs in the northern and central parts of the lake that were of commercial importance at the time they were seen by Dr. Moore, ten years ago. The bottom is composed of comparatively soft mud over the greater part of the lake, the firm areas being confined to those formerly occupied by oyster reefs, and to a comparatively narrow strip along the shore on the southern and western sides. The salinity of the water varies considerably in different parts of the lake, being highest near the southern end and lowest in the northern portion near the pass to Little Bayou du Large. In all parts of the lake, however,

It was always above 1.008, even during the freshets of April and May of this year. The number of diatoms in the water was always large, and the extent of the muddy bottom assures a dependable supply.

In the lower part of *Little Bayou du Large*, between the two passes into King Lake, there are oysters growing, both in the deeper parts of the bayou and also along the banks nearly up to high water mark. On the deeper reefs, in from seven to fifteen feet of water, the oysters are of good quality and fairly abundant. Farther up in the bayou, between the pass to King Lake and that to Lake Washa, the bottom is quite firm for some distance and there are several reefs now almost entirely depleted of oysters. There are wide mud flats at some points in this bayou and near the small branch going to Lake Washa the water is very shallow and the bottom composed of very soft, deep mud. At the times when an examination was made, the salinity of the water in this part of the bayou was rather low—1.0068—but the food supply was abundant and the oysters examined were in good condition.

Bayou Jack Stout is a short bayou opening to the Gulf about three-quarters of a mile to the east from the entrance to Taylor's Bayou. At its upper end it opens into the southwest corner of Bay Jack Stout. There is from twelve to twenty feet of water in the channel, and the bottom is quite firm in the deeper portions. There are now no natural reefs in this bayou.

In *Bay Jack Stout* the water is very shallow except in the channel along the western side of the bay, so that, at low tides in winter, the greater part of the oyster reefs are exposed. The bottom, in the areas between the reefs, is composed of very soft, deep mud, in most places incapable of supporting oysters without the previous application of some hardening material. The oysters on all of the natural reefs examined were densely crowded, and, with few exceptions, were small and of poor quality. In the deeper, western part of the bay there are some good oysters on the natural reefs; but the most of the hard bottom in this part of the bay has been taken up for bedding grounds.

The salinity of the water, in both the bay and in the bayou, was 1.018 as the average of all the determinations made. The amount of food in the water was abundant at all times.

Immediately to the westward of Bay Jack Stout, between that body of water and Taylor's Bayou, there are a number of small shallow bays, most of which contain some small natural reefs made up of small and poorly shaped oysters. The bottom outside of the reefs is generally very soft. The food and salinity conditions are very similar to those in the larger bay just mentioned.

North of Bay Jack Stout there are two small bays known as *Indian Bay* and *Little Indian Bay*. Both of these are connected with Bay Jack Stout, and have openings into Taylor's Bayou on the north. Indian Bay, the one farthest to the westward, has many oyster reefs in its northern portion; while in the southern portion the barren area is proportionately much greater. The water is very shallow in both arms of the bay, so that at low tides in winter, both the reefs, and the flats in the southern arm of the bay, are exposed. The bottom is soft wherever there are no reefs, and the mud is very deep. Little Indian Bay lies just east of the last mentioned body of water with which it is connected by a rather wide pass. There are a few reefs of oysters in this bay; but by far the greater part of the bottom is made up of very soft mud. The water is from two and one-half to eight feet deep, the deeper portion being in the west end of the bay. The salinity of the water in these bays is practically the same as in Bay Jack Stout or in Taylor's Bayou. The amount of oyster food in the water is large.

East of the mouth of Bayou Jack Stout and west of Grand Bayou du Large, there are several small bayous emptying into the Gulf, most of which communicate with small bays or lakes lying between Bay Jack Stout and Sister Lake. All of these bayous are from 8 to 20 feet deep. There are no reefs of any commercial importance in any of these bodies of water; but there are coon oysters along the banks of the bayous as well as some small reefs in the bays.

Grand Bayou du Large, which extends from the southwest end of Sister Lake to the Gulf, is about two miles long and from one-eighth to one-quarter of a mile wide. The depth of

water in the channel varies from twelve to thirty feet, and there are extensive mud flats on either side for the greater part of the length of the bayou. There are extensive oyster reefs, both along the sides of the bayou and in the channel down to a depth of twenty-eight feet. The reefs in the deeper water have never been worked to any extent until within the past two years, and there is an abundance of large fine oysters on them. The oysters on the reefs in the shallower water are also of good size and in excellent condition during the fishing season. The bottom in the deep channel of the bayou is quite firm, while in the shallow portions it is composed of soft mud, except where it has been hardened by the formation of an oyster reef. The salinity of the water was 1.012, and the supply of food organisms abundant.

Sister Lake (Lake Caillou of the Government charts), including with this body of water the small lakes and bays on the north side of Bayou Grand Caillou, contains the most important natural oyster reefs in the Parish of Terrebonne. Including the smaller bodies of water just mentioned, this lake is roughly circular in outline and some five miles across. There are many small passes connecting this lake with Bayou Grand Caillou, between the southwest corner of the lake and Mile Pass at the northeast end. On the north side of the lake there is a pass to Little Bayou du Large and some small bayous connecting it with King Lake.

The water over the greater part of this lake varies from four to six feet in depth, but in the southwestern part the average depth is not more than three feet.

There are extensive oyster reefs all along the southwestern shore in the shallow portion of the lake, and a large, almost continuous, reef running from the deep pass into Bayou Grand Caillou to the point just south of the entrance to Grand Bayou du Large. There are reefs along the south and southeastern shores and a rather large reef in five feet of water off the entrance to Mile Pass. The oysters on the reefs in the shallow part of the lake are all rather small, but of fairly good shape and condition. On the reefs farther out in the lake the oysters grow in crowded clusters and are thin and misshapened. The best marketable oysters are found in some of the smaller bays and



in the deep bayous along the south, and southeast sides of the larger lake. The oysters on all of these reefs have a good many mussels growing attached to them; but in most cases the extra labor involved in the culling is the only trouble caused by this enemy.

During the fishing season of each year most of the salable oysters are taken from these reefs, so that in the spring it is troublesome to find good oysters on any of the reefs in this vicinity. As the reefs are kept fished down so closely there has been a noticeable decrease in the amount of marketable oysters that a man can fish in a day at the present time as compared with the amount usually taken at the time when these reefs were visited by Dr. Moore in 1898. At that time it was stated that a man would make from four to eight barrels as the result of one day's fishing, while at the present time several oyster men of whom I have asked the question, say that from one and one-half to three barrels may be taken as the result of a full day's work on the same reefs.

During the month of April, when the fishing for market is practically over, thousands of barrels of the smaller oysters are taken from these reefs to be "banked" on private bedding grounds. During the past month of April as many as twenty boats could be counted at one time on the reefs in the southwestern part of the lake, and the average number fishing every day in the month would be as high as fifteen. At the present time the drain of the reefs is much greater than their recuperative power, and at the present rate of fishing it will be a question of only a few years at most, before the reefs are brought into a state of depletion such as is represented by many of the reefs in the neighboring bodies of water. Over the greater part of the area outside of the reefs the bottom of the lake is made up of soft mud; although there are many patches, both in the middle of the lake, and in the northeast arm, where the bottom is of sufficient firmness to support seed oysters.

The salinity of the water is usually about 1.012, and it varies little except in times of severe freshets. Oyster food is abundant in the water and the very strong currents assure its distribution to all parts of the lake.

Bay Voisin, which is practically a long arm of Sister Lake, extends from the west side of that lake, above the entrance of Grand Bayou du Large, nearly to Little Indian Bay. It is connected with King Lake by a narrow cut off, and some small bayous going off from its south side connect with Bay Jack Stout.

The depth of water in this bay is very uniform, being about three feet over the whole bay. The bottom is composed of soft mud in the east arm, while in the west arm the bottom is generally harder and there are several well-defined dead reefs. In 1898 Dr. Moore reported that some especially good oysters were taken from this bay; but at the present time, there are no living oysters to be found on any of the reefs. There are a few small reefs of poor oysters in the bayous going off from the south side of the bay, but none of these reefs are large enough to be of any commercial importance. The average salinity of the water was 1.0118, and there were no fluctuations of any importance as a result of the freshets of 1907. The food supply, both in kind and abundance, was very similar to that found in King Lake and in Sister Lake, through both of which the water flows to reach this bay.

Bayou Grand Caillou empties into the Gulf about one-fourth of a mile east of the mouth of Grand Bayou du Large. It runs nearly northeast for about two miles, then bends to the eastward and runs nearly east along the south side of Sister Lake for some five miles, where it bends to the north again and runs far back into the high land. Near its mouth it is about one-quarter of a mile wide, while the average width is about 200 yards. The depth of water in the lower part of the bayou varies from twelve to thirty-five feet in the channel, and there are some large mud flats on either side. There are reefs of oysters beginning at a point about three-quarters of a mile from the mouth of the bayou and occurring at intervals as far up as the salinity of the water is sufficiently high to maintain the life of oysters. The important reefs are all, however, below the point where Mile Pass connects the northeast corner of Sister Lake with this bayou. Some of the reefs in the lower part of the bayou extend entirely across the channel, but most of them are in the shallow water on the sides. Some five or six miles

from its mouth there are reefs in the middle of the bayou that are exposed at low tides. The oysters making up the greater number of these reefs are of very good size and quality. During the past winter some especially fine oysters were taken from the reefs in from twenty to twenty-five feet of water.

The bottom in the deeper part of the channel, between the areas occupied by the oyster reefs, is composed of rather firm, sticky mud, and very soft places are of rare occurrence. Along the sides of the bayou in the shallow water the bottom is generally very soft, except near the mouth of the bayou where there is considerable sand mixed with the mud. The salinity of the water averaged 1.0128, and was very little affected by the freshets. The amount of oyster food in the water was always large.

There are no bays or lakes of any importance on the south side of Bayou Grand Caillou for some five miles from its mouth, *Hackberry Bay*, opposite the middle portion of Sister Lake being the first body of water of any size. This bay is about three miles long and one and one-half miles wide. It opens into Bayou Grand Caillou by a wide pass, and is connected by a narrow bayou with Dog Lake at the head of Grand Pass des Isles. The depth of water over the greater part of this bay varies from two and one-half to four feet, but is considerably deeper near the pass to Bayou Grand Caillou. On the north side of the bay there are some considerable areas of hard bottom, mostly where there have been old reefs. Over the greater part of the remainder of the bay, the bottom is composed of soft mud, in most places too soft to support seed oysters. There are several hard areas in, or near, the mouths of small bayous going off from the southeast corner of the bay; but here also the hard places are those that were formerly occupied by natural reefs. The salinity of the water was 1.0112 in the central part of the bay, and the supply of food organisms was abundant.

Above Hackberry Bay, along the southern side of Bayou Grand Caillou, there are several small bays opening into this bayou and having connections through small bayous with Dog Lake, or some of the other bodies of water farther south in the marsh. In some of these there are some productive natural reefs, besides many extinct ones. The old reefs afford about

the only hard bottom; although some small areas of sufficient firmness to support seed oysters are found outside the limits of the reefs. The salinity of the water in these bays is about the same as in Bayou Grand Caillou, and the food supply was abundant in all instances where an examination was made.

From the mouth of Bayou Grand Caillou the shore line runs in a southeasterly direction toward Last Island, which at this point is separated from the inshore marsh only by a narrow bayou.

Grand Pass des Isles, the first inlet of any size south of Bayou Grand Caillou, opens to the Gulf some six miles from the latter. It is about four miles long, and at its upper end opens into Dog Lake. In the lower part of the bayou the depth of the water varied from fifteen to thirty-three feet. In the upper portion there is from twelve to twenty feet. Throughout the entire length of the bayou there are extensive mud flats on either side of the channel, which are exposed at low water. In the lower part of the bayou the bottom in the channel is composed of rather firm sticky mud. There are numerous reefs of small oysters along the flats in this section of the bayou. In the upper part of the bayou there are some reefs where good oysters occur, and several bedding grounds that occupy bottoms where there were formerly productive reefs.

The water in Grand Pass des Isles is more saline than in the bodies of water farther to the north, the average of all the determinations made during the past spring being 1.0158. The supply of food materials is abundant and well distributed.

Dog Lake, at the head of Grand Pass des Isles, is a body of water about three miles long and two miles wide. Its principle outlet is by Grand Pass des Isles, but it has connections on its south side with Bayou Go to Hell and Charlie's Bay. There is a narrow channel along the western side of the lake where the depth of water is from eight to twelve feet, while over the greater part of the lake the depth is from two and one-half to four feet. The bottom in most places is quite soft, the only places where there was any hard bottom having been taken up for bedding grounds. There are no productive natural reefs anywhere in the lake at the present time. The salinity of the water was 1.0138. The number of diatoms in the water was consider-

ably lower than in the neighboring bodies of water at the time when determinations were made, in March and May, 1907.

Just west of Dog Lake, separated by a very narrow strip of marsh, there is a long, narrow bay (*Bay Bucconi* ?) which communicates with Dog Lake on the north side. The pass to Dog Lake has a depth of six feet in the channel. Over the remainder of the bay the depth of the water is about three feet. The bottom is generally soft, and no reefs were found, either living or extinct.

In the marsh between Grand Pass des Isles and Bayou Grand Caillou, to the west of Dog Lake, there are several small bays and bayous. Most of the bayous are narrow and deep throughout their entire length. The bays are all very shallow, none of them being more than from two and one-half to four feet deep. There are many reefs of small coon oysters in these bays and along the banks of the bayous, but none of the oysters are large enough to be used except for seed.

The salinity of the water in these places is about the same as in Grand Pass des Isles, and the supply of food materials is especially abundant in many of the bays.

Charlie's Bay, southeast of Dog Lake, with which it communicates by several passes, is about two and one-half miles long and one mile wide. The whole bay is very shallow, from two to four feet deep, and the bottom is composed of soft mud except for some relatively small hard areas where there has apparently been oyster reefs. There are scattered bunches of coon oysters along the banks and some unimportant reefs out in the bay. The salinity of the water at the only time that this bay was visited, in May, 1907, was 1.014, the amount of oyster food in the water was large.

About one and one-half miles from its mouth, Grand Pass des Isles is joined by a bayou that is known among the oyster men as *Bayou Go to Hell*. This last named bayou has its source near Bay Des Mangles, some ten miles farther to the eastward, and runs through the marsh in an east and west direction parallel to the coast line. About one mile from its mouth, it gives off a branch that runs to the northeast corner of Pelican Lake. Some two miles farther to the eastward it divides into two branches. One of these runs in a northerly direction and

leads into a series of shallow bays in the marsh east of Charlie's Bay, where its identity becomes lost in a maze of small bayous and lakes. The other branch continues in an easterly direction to the southwest corner of Bay Des Mangles. In the lower part of the Bayou the depth of the water is from twelve to twenty feet, but the channel is generally very narrow, the greater part of the width of the bayou being taken up by mud flats. There are oyster reefs in the upper part of the prong going to Pelican Lake, but all of the good oysters were found on one reef at the junction with the main bayou. The bottom in this part of the bayou is composed of firm, sticky mud, in the channel, and of very soft mud on the flats. Farther up in the easterly branch of this bayou, there are considerable areas of hard bottom, and several productive reefs where some very good oysters were found. The bottom was firmer than in the lower part of the bayou and the mud flats were of comparatively less extent.

In all parts of the bayou the average salinity of the water was 1.0154, and the salinity was very slightly influenced by the freshets. The supply of food organisms in the water was always large and well distributed.

At the head of the northerly branch of the bayou there is a good-sized bay (Bay Go to Hell?). The water in this bay is from three to five feet deep, except near the numerous passes or bayous on the north side, where a depth of from ten to eighteen feet is found.

The bottom is soft over the greater part of the bay, and no oyster reefs of any importance were found, although there were many bunches of coon oysters scattered along in the shallow water near the shore. To the north of the bay just mentioned, the marsh is cut up by a great many small bayous and lakes. Most of the lakes are only shallow expanded portions of the bayous and usually cover an area of only a few acres. All of these lakes which we visited were from two to four feet deep, and the bottoms were composed of very soft mud. The bayous, or passes, were deep, with few exceptions, and the bottoms comparatively firm, being made up of sticky mud. Few oysters were found in any of these bodies of water; but some of them from the deeper bayous were of good size and excellent condition.

The salinity and food conditions in these places were practically the same as in the larger bodies of water near by.

South of Grand Pass Des Isles the first inlet of any size is a pass which connects Bay Wilson with the Gulf. This pass is about one mile long and two hundred yards wide. The water is from twelve to twenty feet deep in the channel, which is very narrow, the greater part of the width of the bayou being occupied by the mud flats. The bottom is composed of firm mud in the channel, while the flats are extremely soft, except on the areas occupied by reefs of small coon oysters.

Bay Wilson, at the head of the pass just mentioned, is about two miles long and one and one-half miles wide. Along the southern part of the bay there is a channel where the depth of water varies from twelve to twenty feet. Over the whole of the northern part of the bay the depth is from two to four feet. Along both sides of the channel across the southern side of the bay, and for some distance up into the shallow portion, there are many old reefs; but so far as could be determined, no living oysters beside those that had been bedded. In the northern part of the bay the bottom is made up of soft mud and there are no old reefs of any size.

The salinity of the water was 1.0158, and the supply of food organisms abundant.

For some years past the hard areas on the old reefs along the channel through Bay Wilson have been used for bedding grounds for planting seed oysters brought from some of the bays to the westward. Of late there has been a general complaint from the lessees of these bottoms that the oysters have not done so well as in past years, and some of the men have gone so far as to give up their leases.

While several conflicting opinions have been brought forward as to the cause of the failure of these plants, an examination of the conditions seems to point to the ravages of the boring sponge (*Cliona sulphurea*) as the chief cause of the trouble. All of the staked-off areas as well as the old reefs were examined and every shell brought up, whether those of living oysters, or those that had long been on the reef as dead shells, were completely honeycombed by the burrows of this sponge. At one of

the camps on the shore of the bay there were several bushels of the shells of oysters that had been opened during the past winter, and each of these showed the same effect of the sponge as was to be observed in the shells now on the reefs. In the living oysters examined, as well as in the shells of those recently opened, many of the burrows of the sponge extended entirely through the shell and had necessitated an unusual secretion of limey material by the oyster to close the openings on the inside of the shells. This unusual drain on the vitality of the oyster would, in part at least, account for their poor condition, and besides the presence of the sponge protruding beyond the shell would serve as a collector of sediment and also interfere with the feeding of the oysters.

On some of the reefs many living conchs (*Purpura haemostoma*) were found, and a large number of the shells of this form were piled around the camps. Very few of the oyster shells, however, showed the attacks of this boring mollusc, and the amount of damage done by it is probably very slight when compared with that done by the sponge.

The most practical way to overcome the trouble caused by the sponge would be to thoroughly clean the beds of dead shells by means of a dredge, so as to destroy the breeding sponges, and at the same time the greater number of the snails would be destroyed. In combatting the conchs the destruction of the eggs is one of the most efficient methods. The egg capsules are prominent purplish masses that are attached to the stakes and other immovable bodies so that they can readily be found and are easily destroyed.

Pelican Lake, just east from Bay Wilson, with which it is connected by a number of passes, is some three miles long and two miles wide. Along the north side of the lake the depth of the water is from five to seven feet; but over the greater portion of the lake it is from two and one-half to four feet. In the southern part of the lake there are several old reefs that are exposed at low tide, while the depth of the water over many of the others is not more than from six to eighteen inches. Everywhere outside of the old reefs the bottom is too soft to support seed oysters. All of the natural reefs have apparently been destroyed, the only

living oysters being found within the areas marked by "lease stakes."

The salinity of the water was 1.016, the supply of food organisms was fairly abundant all over the lake, but greatest near the pass to Bay Wilson, where the currents were strongest.

Bay Rond, south of Pelican Lake, is about one and one-half miles in diameter. It is connected by several passes and short bayous with Pelican Lake, Pelto Lake, and the arm of the Gulf of Mexico, known as "Caillou Bay." In the eastern part of the bay, near the passes to Lake Pelto, the depth of the water is from ten to fifteen feet. Over the remainder of the bay the depth is uniformly about three feet. Along the channel in the deeper portions of the bay there is a considerable area where the bottom is covered with the remains of old reefs. Along the south shore there are also some scattered patches of very hard bottom. Over practically all of the northern portion of the bay the bottom is made of rather soft mud. The greater number of the old reefs over which there is more than three feet of water have been taken up for bedding grounds, and there are a few leases on the soft bottom in the northern part of the bay.

The salinity of the water in Bay Rond is always quite high, the average being 1.0166. The supply of food materials is abundant and constant.

In *Lake Pelto* there are no productive reefs of oysters at the present time, although there are several large extinct reefs in the central part of the lake, and many small beds of oysters in some of the inlets on the north side of Last Island. On all of the extinct reefs there are many whole shell valves, but these are so thoroughly covered with the boring sponge and other animal growths that they are now useless as spat collectors.

The bottom is composed of firm mud over nearly all of the lake, the only soft spots of any size being found in the shallow coves along the islands separating this lake from Cat Island Lake. In the northeastern part of the lake the water is quite shallow, and the islands in the central part of the lake protect this portion from the effects of severe storms, which in the open part of the lake might be very destructive to bedded oysters.

Over the southern part of the lake the water is from five to eight feet deep, the only shallow place being on the crest of an old reef in the central part of the lake.

In the northern and western portions of the lake the salinity of the water is from 1.015 to 1.017. In the east end, near the wide pass to the Gulf, it is higher, sometimes reaching 1.020. The abundance of the food supply varies considerably in the different parts of the lake. In the western end the food organisms are very abundant, especially near the shallow flats on the north side of Last Island. Toward the eastern end of the lake the supply decreases, being least near the junction with Cat Island Lake. In the shallow, more sheltered, northeastern portion the oyster food is abundant and similar in its component forms to that found in the bodies of water deeper in the marsh.

At the northeast corner of Lake Pelto, a narrow pass extends to *California Bay*, a nearly circular body of water lying north-east of Bay Rond. This pass has a deep channel with from twelve to twenty feet of water, and has shallow mud flats on either side. The bottom in the channel is composed of sticky mud, while the flats are very soft. In California Bay there is deep water near the entrance of the pass; while over the remaining portion the depth is about three feet. The hard bottom is confined to the areas along the sides of the channel where there have been oyster reefs. A rather soft mud makes up the bottom over the remainder of the bay.

Bay Long, just north of California Bay, is some four miles long and its average width is about one-quarter of a mile. At its western end it opens into Pelican Lake, and at its east end it connects with a broad shallow portion of Little Bayon Salé. At both ends of this bay the water is very shallow, not more than two and one-half feet, while in the middle portion the depth is about five feet. The bottom is generally soft, being composed of deep mud in the shallower portions and of firmer sticky mud in the deeper middle part. No natural reefs were found in this bay, but there may have been natural reefs on the harder parts that are now occupied by bedding grounds.

In California Bay and in Bay Long the salinity of the water was 1.016 and the food material was abundant.

North of Bay Long there is another bay running nearly parallel with it, which opens at its west end into Pelican Lake, but which ends blindly at the east end. This bay is divided into two portions by a chain of islands about one-third of the way

from Pelican Lake. In the western part, which is nearly circular, the depth of the water is about six feet. The bottom is composed of rather firm mud in this part of the bay. There are no living reefs in this part of the bay, and only a few hard areas marking the location of old reefs. In the eastern portion of this bay the depth of water is less than in the western, and there are several hard areas of considerable extent near the islands separating the two parts of the bay. In the blind pocket at the eastern end of the bay the bottom is very soft, except for a small patch near an artificial cut into Bay Long.

In this bay the salinity of the water and the abundance of the food supply is practically the same as in Bay Long.

Little Bayou Salé (or *Bayou Des Mangles*) opens into Lake Pelto, about one-quarter of a mile east of the mouth of the pass to California Bay. This bayou is narrow for about one mile from its mouth and has a depth of from eight to eighteen feet in the channel. Above this narrow portion the bayou expands into a lake-like portion some three-quarters of a mile long and one-quarter of a mile wide. In this broadened portion the depth of the water is about three feet, and the bottom is composed of rather firm mud. Above this first "bay" the bayou is narrow again for about one and one-half miles, when it forms another bay about one mile long and three-eighths of a mile wide. In this bay the water is from three to four feet deep. The bottom is made up of firm mud mixed with a lot of broken shell. From the northeast corner of this last-mentioned portion, there is a narrow pass into Bay Des Mangles. This bay is some two miles long and one mile wide. The water is from three to five feet deep. The bottom is generally firm.

No productive reefs were found in the bayou or in the bays, the only living oysters outside of the leases being on the shallow flats in the second narrow portion of the bayou.

The average salinity of the water was 1.016. The amount of oyster food was large both in the bayou and bays.

In the small bayous cutting up the marsh between Little Bayou Salé and California Bay there are a great many coon oysters that might be used as seed, and some small patches of rather good oysters in the deeper parts of the bayous.

Grand Bayou Salé, which opens into Lake Peltó, about one mile to the east of the mouth of the bayou last mentioned, is about 150 yards wide for a distance of about one mile from its mouth. The channel is from twelve to twenty feet deep and in most places very narrow. Above the point where a small bayou connects Little and Grand Bayous Salé, the water in the latter is deep clear to the banks. The bottom in the channel is composed of firm mūd; but the shallow flats are very soft. No natural reefs were found in this bayou, and the greater part of the naturally available bottom has been taken up for bedding grounds.

The salinity of the water was 1.0158. The amount of oyster food in the water was large.

In *Bayou Blanc*, and in the other bayous between Grand Bayou Salé and Bay St. Helene, there are no natural oyster reefs of any commercial importance, and the firm areas have been mostly taken up for bedding grounds. The salinity of the water and the richness of the food supply were very similar to those in Grand Bayou Salé.

From the northeast corner of Lake Peltó there is a series of bays connected by deep passes, or bayous, extending to the northward for some eight or ten miles. The first of these bays, *Bay St. Helene*, opens into Lake Peltó by two narrow passes. In the southern part of the bay near these passes the water is from six to ten feet deep; but in the north and east portions the depth is about three and one-half feet. Over the greater part or the southern arm of the bay the bottom is hard and has apparently been occupied by natural reefs, although at the present time the greater part of this area is under lease. In the central part of the bay there is a large hard area formerly occupied by a natural reef. In the eastern extremity of the bay there are a number of old reefs, most of them covering only a small area, however. Over practically all of the bottom outside of the hardened areas already mentioned the surface is very soft; but there are very few places where the mud is very deep.

The water in this bay is very salty for this section, the average salinity being 1.0186. The food organisms are fairly abundant; but less numerous than in the bodies of water farther up in the marsh.

From the north side of Bay St. Helene, a deep narrow pass leads into *Coonrod Bay*. There are a number of small reefs in the pass between these bays, but the oysters on them are of poor quality and the aggregate area of all the reefs is not sufficient to make them of any commercial importance.

The water is from three to five feet deep in Coonrod Bay, and the bottom is almost invariably soft. In *Coonrod Bayou*, and another bayou going off from the west side of this bay, there are considerable areas of firm bottom in the channels covered by eight to twenty-five feet of water. No oysters were found in these bayous, except some small ones in the shallow water along the banks.

The salinity of the water in Coonrod Bay was 1.0158, the food supply being more abundant than in Bay St. Helene.

On the north side of Coonrod Bay there is a broad pass to Bayou Little Caillon, and about one-half mile below this point, on the opposite side of the bayou, there are several passes leading to Bay Premier.

Bay Premier, the farthest south of the shallow bays on the west side of Cat Island Lake, is about one mile long, with an average width of some seven-eighths of a mile. On the east side it is connected with an arm of Cat Island Lake by a deep pass. On the north side there are several passes to Oyster Bay. The depth of water over the greater part of the bay is about three feet, the only deep place being near the entrance of the pass on the east side. The bottom is soft wherever it has not been hardened by the old reefs or the application of oyster shells.

The salinity of the water was 1.0164, the amount of oyster food in the water being fairly large.

In *Oyster Bay*, next north of Bay Premier, the water is from three to four and one-half feet deep, and the bottom is soft outside of the leased areas. There were formerly many productive reefs in this bay, but the areas where they were located have been taken up for bedding grounds.

The average salinity of the water was 1.0158. The amount of oyster food in the water was large.

Bay Couteau, which lies northwest of Oyster Bay and communicates with the latter through a deep pass, is about two

miles long and from 150 yards to one-quarter of a mile wide. Except near the pass at the southern end, the water is shallow, being from two and one-half to five feet deep. The bottom is soft over practically all of the bay. In the pass from Oyster Bay there are some reefs of poor oysters on the flats, and in the southern part of the bay near the head of the pass there is a reef, some ten or fifteen acres in extent. This reef is now so thoroughly depleted that very few oysters could be found on it. Farther up in the bay there are leased bedding grounds that occupy areas of bottom where there had apparently been natural reefs.

The salinity of the water in this bay was 1.0152, and the oyster food was abundant.

From the north end of Bay Couteau a narrow bayou leads to Pumpking Bay, a small, nearly circular body of water, lying in the marsh just east of Bayou Little Caillou. The depth of the water in this bay is from two and one-half to four feet, and the bottom is composed of rather soft mud. The salinity of the water was 1.0152, and the oyster food abundant.

In *Bayou Little Caillou*, between the pass to Bay Couteau and that to Bay Crocodile, the depth of the water varies from one and one-half to ten feet, the deep places being found only near the passes. The bottom is composed of very soft mud throughout all of this stretch of the bayou, and there are no oyster reefs except near the pass to Bay Crocodile. The oysters from this reef, in twelve feet of water, were small and so thickly overgrown with mussels that in many instances it was difficult to tell whether the center of a cluster was a living oyster or a dead shell. The oysters on this reef are always so poor that little use is made of them except for planting in some more favorable locality.

The salinity of the water in Bayou Little Caillou is subject to extreme fluctuations. In May, 1906, and in March, 1907, the average of the determinations was 1.012; while on May 20, 1907, it was 1.000 at the pass to Bay Crocodile, and was very little higher—1.0026—near the pass to Bay Couteau. According to the best evidence obtainable, freshets so severe as that of the past spring are of rare occurrence, and the oysters in the deeper water have been killed by the lowering of the salinity

only very rarely. Since there is, however, a likelihood of the recurrence of freshets, and since the bottom is so generally soft, this bayou cannot be recommended for planting oysters when there is so much available bottom where the conditions are favorable and where there is not the danger from freshets.

In *Bay Tambour*, northeast of Oyster Bay, the depth of the water is from two and one-half to four feet. The bottom is soft everywhere outside of the bedding grounds, which take up the greater part of the area of this bay, and several of these have been made firm by the planting of shells on the soft mud. The salinity of the water was 1.0148. The amount of oyster food in the water was large.

In *Welsh Bay*, east of Bay Tambour, the water is from three to seven feet deep, and the bottom is composed of rather firm mud. In the southern part of the bay there are some very hard areas where the bottom has been hardened by old natural reefs.

From the upper end of Welsh Bay two bayous extend to the west end of Bay Crocodile. The longest of these, *Bayou du West*, makes a long bend to the westward and back again, so that its length is nearly as great again as that of the other one, *Bayou du East*. Some three-quarters of a mile above Welsh Bay there is a broad expanded portion of Bayou du West where the depth of the water is from three to six feet. In the narrow part of the bayou the depth is from eight to twenty feet. The bottom is firm in the deeper portions; but in the shallow places it is very soft. There are some quite extensive reefs of oysters, both in the lower part of this bayou near Welsh Bay, and also in the narrow upper part. The oysters from both of these places are, however, rather small and of poor quality.

In Bayou du East there are some reefs made up of small oysters that are taken to be used for seed. There are many mussels among the oysters on the reefs in both of these bayous.

Bay Crocodile, which is about two miles long and one mile wide, lies along the south side of Bayou Little Caillon, from which it is separated by a narrow strip of relatively high land. A narrow artificial cut-off connects these bodies of water at the northwest end of the bay. The depth of the water in this bay is uniformly about three feet, and the bottom is composed of rather soft organic mud. So far as our examination showed, there are no living oysters in this bay outside of the leased areas.

In Bay Crocodile, and in the two bayous last mentioned, the salinity of the water is generally about 1.014; but during the freshet in April of this year the water in the bay was fresh, and in the upper part of both bayous the salinity was less than 1.002 at a depth of ten feet. As might be expected, there was a great variation in the amount of oyster food found in these waters at different times; but in March, 1907, when the conditions were normal, the food supply was abundant.

The advisability of utilizing these bottoms for oyster culture would depend on the probability of the occurrence of periods when the water is fresh for a considerable length of time. There is no doubt of the restocking of the beds, as there is an abundance of fry in these waters at each breeding season. The only thing to be determined is whether or not the freshets will be too frequent and too severe to allow the oysters to reach a marketable size. In past years destructive freshets are said to have been of infrequent occurrence, so that the best evidence obtainable at the present time would go to show that there are no unusual risks to be encountered in cultivating oysters in these waters.

South of Welsh Bay there is an arm of *Cat Island Lake* some five or six miles long, and one-half to one mile wide, which is separated from the open part of the bay by a chain of small islands. The depth of the water is generally about six feet over all of this body of water. The bottom is composed of firm mud except in some of the shallow places along the shores of the islands on the northeast side. There are some very large old reefs in the central part of this body of water, but no living oysters were found on any of them.

In the upper part of this body of water the salinity was 1.0154, practically the same as in Welsh Bay. In the lower part the salinity was 1.0174. The number of food organisms in the water was always fairly large and varied very little from time to time.

Cat Island Lake (Terrebonne Bay) is about ten miles wide and about the same in its greatest length. In the lower part of the bay the depth of the water is in most places about twelve feet, and from here it shoals very gradually toward the upper end of the lake where the depth is generally about six feet. In

the lower part of the bay near the passes to the Gulf the bottom is composed mostly of sand; but in the upper part it is made up almost entirely of mud. In most places the mud is quite firm, the places where the bottom is too soft to support oysters being along the shores in the extreme upper part of the bay. The salinity of the water in the southern part of the lake, for some three miles from the passes to the Gulf, averaged 1.0189, while in the upper portion—north of the lower point of the chain of islands separating the western arm—it was 1.0158.

In the open part of the lake there are no oyster reefs, and no dead shells are to be found in any amounts. Along the islands separating this lake from Timbalier Bay, there are great banks of shells thrown up by the action of the waves. Almost all of the shells in these mounds are badly broken up and disintegrated, showing that the oysters have been dead for a considerable time, and no living oysters or well-defined hardened areas were found in this vicinity. The extensive changes that are known to have taken place in the topography of this region, make it seem probable that these shells have come from the breaking up of oyster reefs that formerly existed here when this region was made up of nearly continuous marsh, cut up by small bays and bayous, as was true within the memory of many of the inhabitants of this section. With the washing away of the marsh the oyster beds became exposed to the full sweep of storms from the westward and were probably destroyed by the action of the waves. When the reefs were broken up the shells would either be buried in the shifting bottom or thrown up on the islands so that there would be nothing left to which spat might become attached to re-establish the reefs even though there were plenty of fry in the waters.

In the upper part of the lake the danger of destruction by storms is much less, as the bottom is composed of less shifting materials, and there is greater protection against all storms except those directly from the south.

The richness of the food supply varies very markedly in different parts of the lake. In the southern portion, where the bottom is sandy and the salinity of the water is high, the water contains a much smaller number of the food forms than in the northern portion where the bottom is soft and where the tidal

currents cause a constant interchange of water between the lake and the shallow bays in the marsh to the north. In this upper part of the lake the salinity and food conditions are very similar to those found in the neighboring bays and bayous.

Bay Chaland lies at the head of Cat Island Lake, just east of Welsh Bay. It is connected with the former by a narrow deep pass, and with the latter by two cuts, one natural and the other artificial. Except at the south end, near the pass to Cat Island Lake, the bay is very shallow, about three feet, and all over the southern portion the bottom is very soft outside of the areas hardened by the old reefs. There are some small natural reefs in the pass to Cat Island Lake, and in the deeper parts of the pass the bottom is firm outside of the reefs. In the northern portion of the bay the bottom is composed of firmer mud; but there are very few hard areas and no natural reefs of any size or importance.

The salinity of the water in this bay was 1.0144. The food organisms were always abundant in all parts of the bay.

A little way to the eastward from the pass to Bay Chaland, there is another pass leading into a small bay known as *Lost Reef Bay*, or *Bay Perdue*. The water in the pass is from six to twelve feet deep, while in the bay it is from three to five feet deep. The bottom is soft in the shallow portions of the bay and pass, but quite firm in the deeper parts. The greater part of this hard bottom has been utilized for bedding grounds.

The salinity of the water was 1.0124, and the amount of oyster food large.

East of the entrance to Lost Reef Bay, the first entrance to the inland bodies of water is through *Pass La Graisse*. This pass furnishes the outlet for a large number of bays and bayous occupying the greater part of the area between Bay Chaland on the west and Terrebonne Bayou on the east. The depth of water in this pass is about twenty feet. At its inner end this pass opens into *Bay La Graisse*, which is about one mile long and three-quarters of a mile wide at the widest point. The depth of the water in this bay varies from two and one-half to seven feet. The bottom is composed of soft mud over the whole bay except where there is an old reef along the east side near the

middle of the bay. In some shallow coves on the east side of this bay there are some small dead reefs, and some scattered bunches of coon oysters along the banks.

The salinity of the water in Bay La Graisse averaged 1.0126, and the supply of oyster food was abundant.

From the north end of Bay La Graisse a small bayou of the same name connects it with Bayou Terrebonne. In the channel of this bayou where the depth of the water is from ten to eighteen feet, the bottom is composed of firm mud and in part covered by an old reef, where there are a few very fine oysters. The flats on either side of this bayou are quite broad and composed of very soft mud. On the north side of the bayou there is a deep cove where there is about three feet of water over a soft bottom. There are many coon oysters along the banks of the bayou and of this cove.

In *Little Bay Jack*, north of Bay La Graisse, the water is from three to five feet deep and the bottom generally composed of soft mud. There are, however, some quite extensive areas where there were formerly old reefs. Most of the available hardened areas have been taken up for bedding grounds, as none of them were productive as natural reefs. In *Grand Pass Jack* there are reefs bearing some very good oysters; although at the time when these reefs were examined the number of oysters found was rather small. In *Bay Negress* the depth of the water is generally about three feet; but there is an area of considerably more depth near the entrance to Little Bayou Jack. The bottom is quite soft in the shallower part of the bay, but in the deeper portion the bottom is made up of firmer mud and there are the remains of several old reefs. In Little Bayou Jack there is a large oyster reef in the channel near the lower end of the bayou where the depth of the water is from ten to eighteen feet. Outside of this reef the bottom is composed of very soft mud, both in the channel and on the flats. The oysters on this reef were arranged in densely crowded clusters and were of rather poor quality. In Bay Jack the depth of the water and the character of the bottom is very similar to that in the other bays near by. There are no productive natural reefs left in this bay.

The salinity of the water in all of these bays and bayous is normally about 1.012, and food organisms are usually abundant.

During the past spring, however, there was a period of about two weeks when the water in all of the bays above Grand Pass Jack was nearly fresh. The greater part of this fresh water came from Bayou Terrebonne through Bayou Jack. It was impossible to determine at the time of our last visit whether or not the freshet had been severe enough to do any serious damage to the oyster beds; but the oyster men say that there has never been any great amount of damage from that source in past years.

In *Terrebonne Bayou* for a distance of from three and one-half to four miles above the entrance to Bayou La Graise there are, or have been, oyster reefs of commercial importance. At the present time the greater part of the bottom is leased for some three miles above the pass. Above these leased areas there are still some natural reefs; but the danger from fresh water is so great that one would not be justified in planting oysters on any of this bottom. The bottom is soft outside of the areas bearing shells, and in the shallower portions the mud is very deep.

With the exception of about two weeks in April, 1907, the salinity of the water was high enough to assure the well-being of oysters for some distance above the point where any of the leases are located. The average salinity near the pass at the lower end of the area under consideration was 1.0128. The amount of oyster food in the water was always large under normal conditions.

During the heavy rains of the past spring the bayou, down to the entrance to Bayou La Graise, was filled with black, swampy water; although at flood tides the water over the leases for some distance up the bayou became quite salty. The greater part of this fresh water was reported to have come from a canal near the head waters of the bayou, the cause of the escape of the fresh water being the breaking away of the locks in the canal. If this was the case, such an occurrence is likely to be very infrequent, and the unfavorable conditions prevalent at that time should not be given much weight in considering the value of these waters for oyster culture.

In Terrebonne Bayou below Bayou La Graise there is a stretch of about one mile where the water is not more than two feet deep, and where the bottom is composed of extremely soft mud. The filling up of this part of the bayou was brought

about as a result of the changes in the drainage that followed the making of the cut-off into Lake Barre, and the deepening of the upper part of Bayou La Graise. At the lower end of this shallow portion of the bayou there are some small natural reefs, but apparently the deposition of the mud is still going on so rapidly that these reefs are being covered up faster than they are increasing in height, so that their disappearance is only a question of time. Below this filled-up portion the depth of the water is about twelve feet for some three miles or more. All along this portion of the bayou the bottom is covered with shells and is unusually hard. In some scattered spots there are a few good oysters on the old reefs, but they are not of sufficient abundance to be of any commercial importance. A very deep place in the bayou at the entrance to a pass on the south side marks the lower limit of the hard bottom. Below this pass the bayou is deep for some three-quarters of a mile to a point where there is a pass on each side of the bayou. Below these passes the bayou is shallow and the bottom is composed of very soft mud.

Below the pass to Bay La Graise the salinity of the water was 1.0158, and showed no effect from the flow of fresh water farther up in the bayou. In fact, for the purposes of oyster culture, the portion of Terrebonne Bayou below Bayou La Graise, may be considered as a separate body of water since it receives the greater part of its water through the passes from Lake Barre and the passes from the bays on the south side.

On the south side of Terrebonne Bayou, to the east of Bay La Graise, there are several large bays that have passes to this bayou at their upper ends, while below they open into Cat Island Lake or Timbalier Bay.

Bay Jean Pierre, the farthest west of these bays, is some three miles long and one and one-half miles wide. The depth of the water varies from three to eight feet in different parts of the bay. The bottom is composed of soft mud except where there have been old oyster reefs. The old reefs are especially numerous in this bay, so that the hardened areas make up a considerable portion of the whole area. In the northeastern part of the bay there is a large dead reef that extends for at least a mile in an east and west direction, and is from 100 to 150 yards wide.

At the northwest corner of Bay Jean Pierre there is an arm that extends for some three-quarters of a mile along the south side of Terrebonne Bayou, with which it communicates by a narrow pass. The depth of the water in this arm of the bay is from three to five feet, except near the pass to Bayou Terrebonne, where there is a depth of fourteen feet. Near the pass and for some distance out into the center of this body of water there are considerable areas covered by old reefs; but the remainder of the bottom is soft.

In all of the bays south of Bayou Terrebonne the water is considerably more saline than in those to the north of this bayou. The average salinity in Bay Jean Pierre was 1.016, and the amount of oyster food in the water was always large.

Pass Racket Bay, next east of the bay just mentioned, has much the same characteristics as that body of water except that the depth of the water is considerably greater. There are not so many, nor so extensive dead reefs in this bay, but the bottom outside of the reefs is considerably firmer.

East of Pass Racket there are a number of shallow bays among the islands. These bays are all smaller than the two last mentioned, but have much the same general characteristics. The bottom in all of them is composed of rather soft mud. The food and salinity conditions are very favorable for the growth of oysters.

South of Bay Jean Pierre, and Pass Racket Bay, there are many small protected bodies of water among the uppermost of the islands separating Cat Island Lake and Timbalier Bay. Many of these bays contain small dead reefs and in many of them the bottom is made up of clayey mud like that which forms the islands.

The water in these bays is quite salty, salinometer readings of 1.0168 to 1.0196 having been recorded from samples taken from different ones of the bays. The amount of oyster food is large in the northernmost of these bays; but in those farther to the south it is considerably smaller.

Lake Barre, lying east of Terrebonne Bayou, is a body of water about nine and three-quarter miles long and of a width varying from two to three miles. It communicates with Terrebonne Bayou at its eastern end through a cut oppo-

site Bayou La Graise, and through several passes along the south side. At its eastern end it is connected with Lake Felicity by several bayous. At the southeast corner there are passes to Bay Jacko and Bay Baptiste, and through these bays it is connected with Timbalier Bay. The depth of the water in this lake varies from five to twelve feet, the depth over the greater part being about seven feet. The bottom is made up of firm organic mud over the greater portion of the bay; all of the soft places of any size being found in some of the shallow coves along the south side of the bay.

The commercially important oyster reefs are all in one connected area in the western end of the lake and constitute what is practically one large reef, some two miles long and from 200 yards to three-quarters of a mile wide. On some parts of this reef the oysters are in bunches and densely crowded, so that their quality is very poor. On other parts of the reef the oysters are either single or in bunches of two to three. The size and condition of these last-mentioned oysters was the best of any that we took from the natural reefs in any part of the parish. In the open part of the lake, opposite to the mouths of some of the bayous on the north side, there are large areas that have been hardened by the formation of extensive reefs, all of which are now commercially extinct. Off the entrance to the pass to Bay Jacko there is a very large dead reef in about seven feet of water.

At the northwest corner of Lake Barre there is an arm that extends to the north for some three or four miles and which is from three-quarters of a mile to one mile wide. The bottom is composed of firm mud, or clay, soft spots being of very infrequent occurrence.

The salinity of the water in Lake Barre averaged 1.0132, being greatest in the east end and least in the northwest arm. There was little lowering of the salinity as a result of the freshet of the past spring, except in the upper part of the northwest arm. The amount of oyster food was found to be large in all parts of the lake.

Between the northwest arm of Lake Barre, and Bayou Terrebonne there is a series of small bays and bayous having openings into each of these larger bodies of water. The bayous

are all short and usually deep throughout their entire length. The bays are quite shallow, from two to four feet of water being found in different ones. The bottom is very soft in most of the bays, outside of the small areas that have been hardened by the presence of oyster reefs. The salinity of the water and the amount of the oyster food is about the same as in Terrebonne Bayou above Bayou La Grosse.

In *Mud Bayou (Bayou Bourbeau)* there is a reef of oysters that extends across the channel for about one-half a mile from the mouth of the bayou. The bottom outside of the oyster reef is composed of soft mud. The oysters on this reef are arranged in crowded clusters and are of rather poor shape and condition.

In *Bayou Petit Sable* there are several dead reefs in the channel, and a large one along the shore of Lake Barre at the entrance to this bayou. Outside of the limits of these reefs the bottom is soft. In *Bay Au Sable*, at the head of this bayou, the water is from three to five feet deep. There are a few small reefs in this bay, the oysters being in scattered bunches and not forming very well defined reefs. The oysters are not very abundant on any of these reefs, and the ones that we secured were of rather poor quality.

The salinity of the water in this bayou and bay was normally about 1.012; but during the freshet of the past spring the salinity in the bayou fell to 1.0068. The food organisms were abundant in the water except during the freshet when the water was very fresh.

In *Bayou Barre* the depth of the water in the channel is from ten to sixteen feet for several miles from the mouth. There are extensive reefs throughout the lower part of the bayou. In some places the oysters are thick, forming a dense hard reef; but over the most of this area they occur in scattered bunches with patches of soft bottom between the clusters. Outside of the reefs the bottom is covered with the same sort of soft deep mud. The supply of food organisms in this bayou is especially abundant. The salinity of the water averaged 1.0124, but was subject to decided fluctuations during the spring months.

Bay La Peur, immediately to the east of the bayou just mentioned, is about one and one-half miles long and one mile wide. It has connections with Bayou Barre on the west, with

Lake Barre on the south, and with Old Bayou Casse-tete on the east.⁴ The water is about four feet deep over the greater part of the bay, while in the eastern end the depth increases to six feet. There are some small dead reefs in the southern part of the bay, and some few oysters of very good size and quality are found on two small areas; one in the eastern, and one in the northwestern part. The bottom is firm over all this bay with the exception of some small patches along the banks in shallow water.

The salinity of the water was 1.0128. The amount of oyster food was large at each time that an examination was made.

About one-half of a mile east of the entrance to Bay La Peur from Lake Barre, there are the outlets of two bayous, each of which at its upper end opens into Lake Tambour. The westernmost of these bayous, *Old Bayou Casse-tete*, opens into Lake Tambour near the middle of its south side by a broad pass, and from here the bayou continues in a westerly direction for several miles and has another opening into the lake near the western end of the latter. In the portion of the bayou below the first pass to Lake Tambour, the bottom in the channel is covered with an almost continuous oyster reef, the patches of barren bottom being of insignificant size. The depth of the water over this reef varies from three to twenty-two feet. In the barren patches between the bunches of oysters the bottom is composed of very soft deep mud. The oysters taken from most parts of this reef are found in densely crowded clusters, each cluster springing from an old shell buried deep in the mud. The shape and condition of the oysters from most parts of the reef is usually poor, except where the reefs have been broken up to some extent and the oysters liberated from their crowded condition. So far as could be learned the oysters on these reefs are not fished for market to any great extent; but with the reefs in the bayou next to be mentioned they constitute one of the most important seed-producing areas in the eastern part of the parish. Above the first pass to Lake Tambour, there are some oysters in the deeper part of the bayou, and some small reefs along the flats. The greater part of the bottom is barren of oysters and composed of soft mud.

Except in times of unusually severe freshets, the salinity of the water in this bayou is about 1.014, and the amount of oyster

food abundant. The poor condition of the oysters is to be attributed to their crowded condition and not to any deficiency in the food supply.

In the lower expanded portion of *Bayou Bas Bleu*, known as *Bay Bas Bleu*, there are oysters scattered over practically all of the bottom in from four to twelve feet of water. The bottom is here composed of a fine gravelly material, but is rather soft. Above Bay Bas Bleu the oyster reefs are nearly continuous across the bayou for a distance of from one mile to one and one-half miles. The depth of the water varies from four to twenty-four feet over these reefs. In the broad upper end of the bayou there are oysters in scattered bunches over a large area. In this section of the bayou there is no well-defined reef; but practically the whole of the bottom is covered with the large bunches of densely crowded oysters, the clusters being separated by small patches of very soft barren bottom.

The salinity and food conditions are practically the same as in the last-mentioned bayou. There are leases near the lower ends of both these bayous; but the oysters taken from these planted beds were in poor condition. The greatest drawback to bedding in these waters seems to be the especially heavy set of spat that occurs each season. Seed oysters put down in early spring become covered with a dense growth of young later in the season, so that their feeding is interfered with and the whole cluster becomes so densely crowded that no good-shaped oysters will be produced. Under present conditions this locality provides a valuable place for catching spat to serve as seed, but the probability of the adult oysters being covered up by the young at each breeding season makes its value as a planting ground very slight.

Lake Tambour, at the heads of the bayous last mentioned, is some four miles long and from one mile to two and one-half miles wide. The depth of the water in this lake is from three to seven feet. The bottom is almost universally soft. There is a large reef in the eastern end of the lake above the entrance of Bayou Bas Bleu. The oysters on this reef as well as on some planted beds in the northwestern part of the lake are badly overgrown with mussels.



The salinity of the water was 1.0126, and was decidedly influenced by the freshets. The amount of oyster food was smaller than in most of the neighboring bodies of water.

In the marsh between Lake Tambour and Lake Felicity, there are a number of small bayous and ponds, but none of them contain any oyster reefs of any commercial importance. All of them are, moreover, too small to be of any special value for cultural purposes.

The conditions as regards the salinity of the water and the amount of oyster food that it contains, are very similar to those found in the larger bodies of water bounding this area.

Along the south side of Lake Barre, near its eastern end, there are several bays which have communication both with this lake and with Timbalier Bay. Two of these, Bay Jacko and Bay Baptiste, are by far the largest, and as they possess all of the characteristics of the smaller ones, will alone be discussed.

Bay Baptiste is about two miles long and one and one-half miles wide. It is separated from the adjacent bodies of water by small islands between which there are passes, where the water is two or three times as deep as in the body of the bay. The average depth of the water is about three feet over the open portion of the bay, while near the southern end the depth increases to ten feet. A large part of the whole area of the bottom—as much as forty per cent—is covered with the remains of old reefs, and is very hard, although in many instances all of the reef except the crest has been covered by a deposit of sediment several inches in thickness. Between the reefs the bottom is made up of very deep soft mud.

East of Bay Baptiste, *Jacko Pass* extends from Lake Barre to Timbalier Bay. In its upper portion the water is from four to six feet deep and the bottom soft. In the middle portion the greater part of the bottom is covered with the remains of the old reefs. Many of these reefs are covered by only one to three feet of water, and the bottom is very soft between them. In the southern part of the pass the depth of the water is from six to twelve feet, and there are old reefs over the greater part of this area.

Bay Jacko extends east from this pass for some two miles, and has an arm extending to the south for one mile or more. In

the portion of this bay nearest to Jacko Pass, the bottom is mostly composed of soft mud with only a few small hard areas. Farther to the eastward, and in the southern arm of the bay, there are many old reefs covering a considerable portion of the bottom. The salinity of the water in these bays averages about 1.0158, being influenced by the flow from Timbalier Bay, where the salinity is always higher than in a corresponding part of Cat Island Lake. The amount of oyster food in the water is always *large* and the currents are unusually strong for such shallow bodies of water.

Lake Felicity, lying to the eastward of, and a little northerly from, Lake Barre, is a body of water five or six miles long and about two and one-half miles wide. It is connected with Lake Barre through Bayou Casse-tete, Bayou Racoon, and, more indirectly, through several bayous and lakes farther to the southeast.

Lake Chien, at the northwest corner of Lake Felicity, is a broad arm of the latter lake some two miles in diameter. At its eastern end Lake Felicity empties into Timbalier Bay through a good-sized bayou known as Grand Pass Felicity, or Felicity Pass. The depth of the water in this lake varied from four to eight feet. The bottom is generally soft, very few firm areas being found anywhere in the lake outside of the living or extinct reefs. There are several living reefs covering a large area in this lake, all of them being situated near the shores, none of them more than one-half mile from the banks. There are a number of small reefs in the west end of the lake near the entrance to Bayou Casse-tete, and a couple of extinct ones near the entrance to Lake Chien. In Lake Chien there are two large areas where the oysters occur in scattered bunches hardly constituting a well-defined reef. On the north side of Lake Felicity there is a more or less well-defined oyster-bearing area that extends along for nearly three miles parallel to the shore line in from three to six feet of water. Toward the west end of this area the oysters occur in scattered bunches, and the barren spots are more extensive than those bearing oysters. Farther to the eastward the oysters become thicker so that there is a well-defined reef. On the south side of the lake there are oysters practically all of the way from the entrance to Bayou Casse-tete to Grand Pass.

Felicity, although there are considerable variations in the denseness of the reef. Most of the oysters from all of these reefs are of poor shape, and whenever we took up any they were of poor condition. There were a great many mussels among the oysters on the reef along the north side of the lake, and some, although a much smaller number, among the oysters on the reefs along the south side. On all of the reefs there were a great many *Crepidulas* attached to each of the oysters. Besides these molluscan companions most of the oysters from the southern reefs were completely covered with large numbers of a small *simple ascidian*.

While there is no evidence that these animals are directly harmful to the adult oysters, they make the shells of the oysters on the reefs so dirty that there is little chance for the spat to become attached and thus hinder the restocking of the reefs.

The oysters from Lake Felicity are mostly taken to be used for seed and it is said by the oyster men that these oysters do not get fat during the winter season when the fishing for market is being done .

The salinity of the water in this lake averaged 1.0153. The amount of oyster food in the water was smaller than in most of the bodies of water in this region.

There are two reefs in *Bayou l'Eclat*, where the oysters are arranged in scattered clusters as on the reefs in Lake Felicity. Farther down in the bayou there are some hard reefs where there are a few good single oysters. In *Lake l'Eclat* there are some extinct reefs, but no living oysters outside of the bedding grounds.

South of Lake Felicity there is a good-sized body of water, *Lake Little*, which communicates with the former lake by two bayous—*Bayou Le Vicux* and *Bayou La Vieille*. In both of these bayous there are dense reefs of oysters, but the bottom everywhere outside of the reefs is composed of soft, deep mud. Lake Little is some five miles long and two miles wide at the widest point. At the south end of the lake there is a bayou that goes to Timbalier Bay, and a connection with Bay Jaeko through a series of small passes and bays. The water is from four to six feet deep in this lake. In the northern part of the lake there are some small oyster reefs surrounded by a soft, muddy bottom. In the central and southern parts of the lake the bottom

is composed of a clayey mud and makes up one of the largest continuous areas of hard bottom found anywhere in this region.

The salinity of the water in this lake was 1.0158. The number of diatoms in the water was smaller than is usual in this section.

Between Bayou Le Vieux and Bayou l'Eclat there are several small bodies of water that have openings into Lake Felicity and Lake Little. The bottom is firm in most of these ponds and the depth is from four to seven feet. The salinity of the water and the number of food organisms is practically the same as in the larger bodies of water with which they communicate.

In *Grand Pass Felicity* the depth of the water in the channel varies from eight to twenty-five feet, while the mud flats, especially near the ends of the pass, are very broad, taking up the greater part of its width. The bottom is quite soft in the channel and no oyster reefs were found in the deeper water. Along the flats there are some extensive reefs. One of these along the south side of the pass near its entrance to Lake Felicity is made up of rather scattered clusters of poorly shaped oysters growing on the soft bottom with rather large barren areas between the clusters. There are several smaller reefs along the flats farther down in the pass that have much the same characteristics as the one just mentioned.

At the lower end of the pass there is a large reef along the northern shore. The oysters on this reef are arranged in long, densely crowded clusters of from six to twenty individuals. There are some few good-sized oysters among those at the bases of the clusters, but by far the greater number were small and greatly elongated. The bottom is very soft everywhere about the reef and in the barren spots between the clusters.

The salinity of the water and the abundance of the oyster food is about the same as in Lake Felicity.

There are many small bays and bayous in the marsh south of Felicity Pass, between Lake Little and Timbalier Bay. All of these are intimately connected with each other and with the larger bodies of water which bound this area. Most of the ponds have a depth of from three to seven feet. In some of the bayous the depth reaches twenty feet. There are many insignificant reefs of coon oysters in these ponds, but none of them are of

any commercial importance. The bottom is in most cases made up of very soft mud; but in some of the ponds it is of sufficient firmness to support seed oysters. The salinity of the water in most of these ponds was about 1.016, and the amount of oyster food was always large.

The only portion of *Timbalier Bay* visited was that which lies to the north of the mouth of Grand Pass Felicity. Along the northwest shore of this bay above this pass there are several small dead reefs where no oysters were to be found. Farther to the north there was a good-sized productive reef lying in a deep cove. When this reef was visited, in May, 1906, it consisted almost entirely of small oysters and shells—apparently the cullings left from the fishing of the previous winter. The absence of all large oysters would indicate that the reef was being fished beyond its power of recuperation, and that its destruction is an assured fact if the present rate of fishing is continued for a few years longer. In some small bays at the northern extremity of Timbalier Bay we found several old reefs; but none where there were living oysters in any abundance. On the northeast side of the bay there were some old reefs; but no living oysters were found outside of the leases. The bottom was everywhere soft outside of the living or extinct reefs. In some places it was so soft that a pole would sink to a depth of several feet of its own weight. In other places the bottom was firm enough to support seed oysters; but the firmer areas were of limited extent and widely scattered.

OYSTER PLANTING IN TERREBONNE PARISH.

The most important change that has taken place in the status of the oyster industry of Terrebonne Parish in the ten years since this region was visited by Dr. Moore has been the more general application of cultural methods. Within this period of time it has become more and more apparent to everyone connected with the oyster industry that the supply from the natural reefs was by no means adequate to fill the demand for oysters in the markets of this State to say nothing of looking to those of a greater territory. While in 1898 practically all of the oysters taken in this parish came directly from the natural reefs, at the present time the greater part of them come from

private bedding grounds; although, even in this case, the greater number come primarily from the natural reefs, since the practice of planting clutch has been adopted in so few instances.

In 1898 there was but thirty-two leased areas in this parish, which, under the laws then in force, could include a maximum area of only 320 acres. At the present time there are leases in this parish which all together make up an area of 8,455.65 acres. By far the greater number of the leases are of less than ten acres in extent, while leases of over one hundred acres are of rare occurrence and have all been taken up within the past two or three years.

In most cases the oysters on the leased bottoms are those that have been taken from the natural reefs and transplanted to some other locality where the conditions for their growth were more favorable. Some times much care is exercised in the preparation of the seed, but more often there is a good deal of laxity in the manner in which it is handled. In the first place scant attention is paid to culling when the oyster men are taking seed: everything brought up, including the smallest oysters and sometimes empty shells, is dumped into the boats without any attempt to break up and sort the clusters. When these oysters are put down on the bedding ground, unless it is exceptionally hard over all the surface, many of the oysters in the larger clusters will be forced into the mud where they will surely be suffocated. The greater weight of the living oysters at the upper end of the cluster will cause that end to reach the bottom first so that the useless empty shells will be kept above the mud, while some of the living oysters become the support for the whole colony. Besides the consideration of the oysters actually lost by being covered up in the mud, the laxity in planting operations of this nature directly defeats the most important ends that are to be gained by the transplanting of the oysters. The poor shape and condition of the oysters on the natural reefs, especially when the reefs are surrounded by a muddy bottom, is usually due to the crowding among the individuals of each cluster and not to any fault in the physical or biological conditions in the body of water in which the reef occurs. The amount of oyster food in the water in which the oysters are to be "banked" may be no greater than in the water from which they were taken; but

when the clusters have been broken up and the oysters scattered, the amount of food available for each individual becomes greatly increased.

It has been shown by experiment that the shape of an oyster is to a great extent dependent on whether or not there is room for each one to grow to its normal shape, and, since the volume of the body of an oyster depends upon its shape rather than on the length of the shell, those that have grown under favorable conditions will have a volume several times as great as those with the same length of shell taken from crowded clusters. It has also been determined that the power of acquiring the normal shape when released from oppressive conditions decreases in proportion to the age of the oyster, so that the increase in value will be greatest in young seed that has been carefully separated and well scattered over the bedding ground. It is clear, therefore, that by the use of lax methods of "banking" there is a much smaller return for the labor expended than there would be were more attention given to the selection and preparation of the seed before planting.

In most instances the areas selected to be used as bedding grounds have been those where the bottom has been already hardened by the presence of a natural reef. This fact in itself imposes a hard and fast restriction to the amount of bottom that may be leased in one place since the old reefs are usually rather limited in extent, and the surrounding bottom in most of the bodies of water in this region is too soft to support seed oysters. In some few instances shells have been planted as a means of catching spat; but, so far as I could learn, no effort has been made to utilize the soft patches in the leases where seed oysters are "banked." The soft spots are left barren and bottom leased in some other places instead of some hardening material being applied to bring these patches to a consistency such that they could be utilized and a continuous bed established. In many cases the oyster men complain that all of the "good" bottom in a certain body of water has been taken up, and they regret the necessity of having to lease small areas in widely separated places, apparently giving no thought to any method of utilizing the bottom not already hard enough to support seed oysters.

SPAWNING OF THE OYSTER IN TERREBONNE PARISH.

Observations on the spawning of the oysters in these waters were of necessity limited to the spring months. In the latter part of March, 1907, when the beds in the western part of the parish were visited, the oysters from all of the beds in shallow water were "milky"—that is, with well-developed gonads. At the same time those taken from the deeper parts of the channels in Bayou Du Large and Bayou Grand Caillou, were fat, and the gonads were just beginning to become noticeable. There were few spat to be found on any of the shells taken up during the month of March and the first half of April. From the evidence collected during the two seasons in which these waters were visited it seems that by far the greater part of the sexual products are thrown between the 15th of April and the 1st of July. The spawning season seems to be some two weeks earlier in the western part of the parish than in the eastern part, when bodies of water of the same depth are compared. This may in part be accounted for by the fact that in the bodies of water to the westward the influence of the spring freshet is felt sooner than in those farther to the east. In the same general region there are, however, some very noticeable differences in the time of spawning that cannot be accounted for on the ground of changes in the salinity of the water. In such cases it is probable that the temperature has a great deal of influence, as the oysters in the shallow water become "milky" before those from greater depth where the temperature is lower. The weight of evidence seems also to point to the fact that the oysters which have the most abundant food supply ripen their sexual products earlier than their less fortunate neighbors. These oysters would also cease breeding before the others and in the fall are the ones that first become fat enough for market.

ENEMIES OF THE OYSTER.

The most destructive enemy with which oyster planters have to contend in the waters of Terrebonne Parish is the drum fish, or black drum (*Pagónias cromis*). This form does the most of its damage to seed oysters or to bedded stock, and is of no great damage to the natural reefs, except in that it sometimes destroys

many of the small oysters less than two inches long. The older oysters on the natural reefs are protected by the knife-like edges of their shells, which will lacerate the lips of the fish if it makes any attempt to destroy them. When seed oysters are taken from the natural reefs, or when, during the fishing season the culled oysters are "banked" to await the completion of a load, the fish are likely to do the greatest amount of damage. After the oysters have been banked for a few weeks they are practically safe from the attacks of this enemy; either because they settle into the mud, or because they become covered by a deposit of sediment sufficient to render them inconspicuous on the bottom.

The drum is more or less troublesome in all parts of the parish, but seems to be especially abundant in the vicinity of Lake Pelto, and in the bays above Bay Saint Helene. Many of the lessees of small bedding grounds when planting seed oysters enclose the entire area with a fence made up of small stakes that will stand for a few weeks until the danger from the attacks of this enemy is past. When fishing for market on the natural reefs the oyster men usually enclose a small area where the culled stock can be safely kept until it is taken up to be sold. The same method of procedure is frequently followed by the owners of leased bottoms when working over their stock, the marketable oysters being put in a protected place, as the loss can thus be in a great measure guarded against.

A boring sponge (*Cliona sulphurea*) occurs more or less abundantly on all of the living and extinct reefs in Terrebonne Parish. In most cases the amount of the damage done to the living oysters is very slight; but on the old reefs this sponge is one of the most active agents concerned in the disintegration of the shells. Besides breaking up the shells by means of its innumerable small burrows, the sponge covers their outer surface with a layer of slimy matter, to which spat cannot become attached thus making the shells useless to perpetuate the reefs. In some few places, particularly in Bay Wilson, as previously mentioned, the sponge becomes sufficiently abundant to infest practically all of the living oysters as well as the dead shells. In such cases the vitality of the oysters is lowered by the constant necessity for the increased secretion of limey materials to close the openings of the burrows that extend through the shell.

and open into the mantle cavity of the oyster. The presence of the sponge has also a detrimental effect on the appearance of the oysters when they are exposed for sale in the markets and lessens their value for canning.

The mussel (*Mytulus homatus*) is found among the oysters on most of the natural reefs, and to a less extent among the planted oysters. Usually the number of the mussels is comparatively small, so that the damage is practically nothing. On some of the natural reefs, however, the oysters are practically covered with the mussels, so that all of the water has to pass through among the mussels before reaching the oysters. As the food of the oyster and of the mussel consists of the same kinds of microscopic plants, the presence of large numbers of the mussels necessarily cuts down the amount of food that is available for each, so that oysters taken from the badly "musseled" reefs are always very poor. When the oysters are being taken for market it is very difficult to cull off the mussels so as to make good appearing stock, and when taking seed an extra amount of culling is necessary or else a good part of the load will be made up of the mussels which are not only useless as seed, but also positively detrimental to the well-being of the oysters that are being planted.

The conch, snail, or borer (*Purpura haemostoma*) is found on the oyster beds in practically all parts of the parish; but is most abundant where the salinity of the water is highest. Although considerable damage is attributed to the attacks of this enemy, the evidence of its depredations is very meager. Some few small oyster shells are found with a hole in one valve such as might be made by this snail, but the number of shells attacked in this way is always small and there is no first hand evidence that the borings were made by the *Purpura*. Since we lack any conclusive evidence in this matter it is safe to consider this form as an enemy and to destroy them whenever possible. A great deal can be accomplished toward their eradication by destroying the egg capsules, which are conspicuous, brightly colored bodies, attached to the stakes, and other pieces of wood, about the oyster beds. Large numbers of the adult snails are taken up when the beds are being worked in winter and if these were destroyed instead of being thrown back with the cullings, the number of any bed would be materially reduced.

The stone crab (*Menippe mercinaria*) occurs in all the oyster producing waters of the parish. Usually the number in any locality is not large enough, so that they do any noticeable amount of damage, but on all of the beds some of the shells of small oysters are to be found with the edges of the shells broken away, showing the characteristic effects of the attacks of this enemy.

A small boring clam (*Martesia cuneiformis*) is found infesting the living oysters and dead shells on most of the natural and planted beds. The damage to the living oysters was inconsiderable in any instance noted; but on the old reefs this form is one of the active disintegrating agents.

FRESHETS.

Observations during the freshet seasons of two years, when there was heavy damage from fresh water in other parts of the State, have shown that the oyster beds in this parish are unusually free from damage resulting from an excess of fresh water. On the western side of the parish there are some bodies of water where the danger from freshet is so great that any attempt at oyster culture will be very hazardous; but over the greater part of the oyster-producing area the salinity of the water is very stable and the drainage of the upland country is such that there cannot be any great influx of fresh water to destroy the oyster beds. Whenever there is a freshet the area affected is usually very limited and the normal salinity of the water is soon established, since there is ready communication with the saline waters of the Gulf. The most persistent flow of fresh water noted during the past two seasons was occasioned by the breaking of the locks in a canal far back in the country, near the head waters of Bayou Terrebonne, so that the freshet was not due directly to the heavy rainfall that occurred at this time. This last-mentioned occurrence calls attention to a problem that is becoming of more importance each year, namely, the effect on the oyster-producing sections of the State of the many drainage canals that already exist or that are to be dug in the near future. Unless some provision is made for the holding back and the gradual release of the surplus water there will be small local freshets near the mouths of the canal systems each time a

heavy rain occurs. While these freshets may never be of sufficient severity to involve a large area, they will exclude oyster raising from the areas near the outlets of the canals, and when the canals become numerous, they might involve much otherwise available bottom within the limits of their influence. It is also very noticeable, in the oyster-producing section of this parish, that any changes in the drainage resulting from the cutting of even small canals or passages may bring about results entirely unexpected, both in kind and in magnitude. The interest of those engaged in the oyster industry demands that all canal projects be subject to expert scrutiny by some one conversant with the present drainage conditions, and that, in so far as possible, the outlets of the drainage systems should be put where the least damage to the oyster industry can result.

CONCLUSIONS AND RECOMMENDATIONS.

The oyster industry of Terrebonne Parish, as well as that of the State as a whole, has now reached a stage when it is very evident to every one with a personal knowledge of the existing conditions that the dependence on the supply from the natural reefs must be given up. A comparison with the conditions ten years ago in the section under consideration shows that where at that time important natural reefs existed, at present no living oysters are to be found, and, in so far as the data compiled at that time are explicit as regards abundance, there is found to be a marked decrease in the supply at present on all of the reefs. The men most acquainted with the past and present conditions give estimates varying from five to ten years as the possible length of time it will require to totally destroy the natural reefs at the present rate of fishing, and an unprejudiced study of the available data makes it appear that the longer period is well within the probable limit. In this connection it may be pointed out that the taking of seed is much more destructive to the natural reefs than is the taking of oysters for the market, as in the latter case only those above moderate size will be carried away, and the cullings will be returned to the reef to increase in size or to serve for the attachment of spat as the case may be. On the other hand as the practice of taking seed is usually carried on, the culling is much closer in regard to the

size of the oysters taken, so that very little except the empty shells and other inert, or even harmful, material is returned to the reefs. The proportion of harmful materials, chiefly mussels, conchs, sponges, etc., is relatively much higher on a reef from which seed is taken than on one from which oysters are being fished for the market, so that the reefs are left in much the worse condition in every particular. During the past spring—April, 1907—the amount of oysters removed from the natural reefs to be used as seed was generally agreed to be greater by thousands of barrels than the amount taken in any previous season; while the amount fished for market during the winter was, in proportion to the supply, as large as has been usual in years past. It is evident, therefore, that the drain on the natural reefs is increased under the cultural methods now in use, instead of being lessened as would be the case if the most advanced cultural methods were practiced.

With the lessening of the supply of oysters on all of the natural reefs, and the total failure of some of the formerly productive ones, those engaged in the cultivation of oysters are brought face to face with the necessity of going longer distances for their seed and also with the fact that the returns for the same amount of time and labor in taking seed becomes less and less as the supply on the natural reefs diminishes. Besides these considerations, it will be noted that the quality of the seed will be lowered and a much greater amount of useless materials will have to be handled to procure the same amount of seed as the reefs are worked down more closely. As a natural result of these conditions there will soon come a time when it will be more economical for each planter to raise his own seed, or to procure it from some one who makes a business of this phase of oyster culture.

Under the present oyster law the taking of seed is confined to the period between September 1st and April 30th, and in practice it is chiefly carried on during the month of April, when the weather has become so warm that there is difficulty in keeping oysters long enough to get them to market, and after they have begun to have well-developed gonads—or have become milky. With a general adoption of the practice of raising seed on leased bottom, the restriction as to the time when seed can be taken

would be done away with and the work of "banking" could be carried on later in the spring when the open season for the natural reefs is over.

Under the conditions on the Louisiana coast, where a bountiful set of spat may, in most cases, be assured if only some clutch is exposed, it would seem to be most economical for each oyster planter to raise his own seed; but in certain sections where it is said that an abundant set of spat is of rare occurrence, recourse might be had to the other method.

In those sections along the Atlantic coast where the artificial culture of oysters has been brought to the highest state of perfection, it has been found most practicable to utilize for seed production the areas where the set of spat will most often be heavy; and it usually happens that these places are the ones where the growth of the adult oysters will not be so rapid as in other places less adapted for the catching of spat. The two phases of the industry are thus seen to supplement one another and to put to its best use each of the different areas of bottom. In the waters of Terrebonne Parish there are many areas well adapted for the production of seed, and while on the most of these the oysters may be raised until ready for the market; for the lessee of any large areas of bottom the depth of the water in the places best adapted for seed production is too little for the operation of the implements best adapted for working the adult oysters.

In reference to the differences between the needs of the small planter and those whose operation are on a larger scale, it may be mentioned that while any depth of water less than ten feet is well adapted to the use of tongs, it is necessary for working a drag successfully that the depth be over six feet, and even eight feet of the drag be of large size. Besides, the use of modern implements makes possible the utilization of bottoms beyond the depth where hand tongs can be worked profitably if at all.

The study of the conditions in this parish has shown that in many places where the depth of the water is too great for the tongmen to work easily, the bottom and the salinity of the water are very favorable for the cultivation of oysters. It is usually true, moreover, that the swiftest currents are found in the deeper bayous so that there is a constant renewal of the

water which keeps the food supply up to a high average all the time. As a natural consequence of the conditions existing in these deeper places they are capable of affording good growing conditions for a greater number of oysters than is the same area of bottom in the shallow bays where the currents are more sluggish and the dissemination of the food organisms less active and complete. These bottoms in the deeper bayous, on account of the exceptional food supply, could be best utilized by employing them for "fattening" or "finishing" grounds for oysters that had been grown on some less favorable bottom. The possible additional handling that such a course might involve, provided that the oysters were worked over twice before being put on the fishing beds, has been shown, in every case where cultural methods have been followed, to be well worth while and is more than compensated for by the increased value of the product.

By the adoption of the use of modern methods it would be possible to make use of the bottom in some of the larger lakes where the depth of the water is too great for the bottom to be taken up by the lessees of small areas. In these larger bodies of water there is also a chance that it may be too rough to work from a small boat for days at a time, while this feature would not be troublesome to large boats working drags except in times of severe storms.

For the lessee of large areas of bottom there is a decided advantage in having his holdings as compact as possible, which can be accomplished in the larger bodies of water only without covering the entire bottom and thus encountering the danger of overstocking the bottom, which feature will be discussed farther on in this report.

UTILIZATION OF SOFT BOTTOMS.

A perusal of the statements of the conditions in the bodies of water in this parish suitable for the growth of oysters shows that by far the greater part of the bottom in all of them is composed of mud, in most cases, too soft to support seed oysters. When any hard bottom exists it is found to be, with few exceptions, those areas that have been the locations of oyster reefs. As these hardened areas were, in most of the bodies of water, the only areas naturally available for the banking of oysters, they

were taken up first, so that at the present time there are few hard areas not under lease. In the light of these facts it is very evident that the expansion of the oyster industry must, in a great measure, depend upon the utilization of bottom not at present in a condition to receive seed oysters. In discussing the means of utilizing these bottoms, two conditions which require different treatments present themselves, namely, the utilization of soft places in leases, and the utilization of large areas of soft bottom.

In the first case, the leaving barren of more or less extensive patches in a lease causes an unnecessary outlay in the rental of the area in which it is included, and very frequently makes necessary the leasing of other bottom, sometimes of necessity several miles removed. Fortunately the materials necessary for reclaiming these areas are readily available near the sections where oyster culture is carried on. While the oyster shells from the canneries might be used to bring the bottom to a firmness such that it would support the seed, they would also serve for the attachment of spat so that this portion of the bed would be stocked with young and the working of the marketable stock interfered with, while a good surface for the banking of seed would not result. On the other hand there are, along the islands making up the outer side of the marshy area in the western part of the parish, as well as on some of those in Cat Island Lake, immense banks of fragments of oyster shells and the shells of one of the small snails (*Littorina irrorata*, Say). This would make an excellent hardening material, and on account of the small size of the fragments, they would remain above the mud to become covered with young oysters. On the islands separating Lake Pelto and Cat Island Lake from the Gulf, there is a practically unlimited supply of sand, and this material has, in the hands of the northern oyster planters, proven to be one of the best materials for the hardening of soft bottom for the reception of seed oysters.

If the area of soft bottom is large, as when the lease is to be taken up in a body of water where the bottom is everywhere soft, the method just mentioned is not to be recommended, unless the location offers special advantages for the finishing of mature oysters. The most practical method of procedure, by the use of

which two ends are gained, first the hardening of the bottom, and secondly the stocking of the bottom with young oysters, is to cover the bottom with whole shell valves, or with other large clutch in such quantities that some of the material will remain above the mud to offer a place of attachment for the spat. In some localities where the bottom is composed of very deep soft mud it might be found best, and most economical, to make a surface of sand or of other fine material, on top of which the clutch could be spread, although practically any bottom can be hardened by the application of a sufficient quantity of oyster shells. The important point in the consideration is the comparative cost of the different materials and the fact that by using shells entirely many of them would be lost that might, by the other method, be utilized for clutch. If the hardening of a very soft bottom is done by the use of shells alone, it usually happens that the set of spat will be so heavy that it will be necessary to work over the young growth within a few months of the time of their attachment. If the surface is made of some other material, the clutch can be put down in such an amount that there will be little likelihood of excessive crowding among the young oysters until they are one year old. In any case it is essential that the bed be worked over within the year, or there will be a second growth of young on those that first became attached to the shells.

OVERSTOCKING OF SMALL BODIES OF WATER.

Since the planting of oysters has become general in the waters of Terrebonne Parish, it has been found that in some localities the quality of the oysters produced has gradually deteriorated, and it has been noted that in these places the oysters fail to fatten as early or as quickly as formerly. In all cases where this condition was called to the writer's attention, it was found that the areas concerning which there had been the most cause for complaint were those that formerly produced oysters of particularly good quality. In most instances these leases were situated in small bodies of water, and the area under lease made up the larger portion of the whole bottom. Often the barren area was confined to a narrow strip along the shore, and all of the remainder of the bottom was covered with banked oysters or

with clutch. The prevalent opinion among the oyster men as to the cause of this trouble seemed to be that the large amounts of oyster shells used for clutch had some detrimental chemical effect on the water. In many cases there has sprung up, as a result of this opinion, a decided prejudice against the method of planting clutch, or at least, of using oyster shells for clutch.

A comparison of the conditions in these and other bodies of water points to another factor as being the cause of the trouble. In the localities where there was the most complaint from this source it was found that the food contents in the stomach of each oyster was very small, although the number of food organisms in the water was about as normal for other bodies of water in the region. Thus it appears that the source of the trouble is to be found in the fact that there was an insufficiency of food for each oyster, since the number present called for more food than the barren bottom could supply. The fact that the greater part of the bottom is covered by the oysters or by the shells, necessarily limits the number of diatoms that can grow in these bodies of water, as it is known that these plants live mostly at the surface of the mud, and multiply when they are at rest on the bottom. As most of these densely crowded bottoms are in nearly landlocked bays, it follows that there can be no nearby supply of food materials that can be brought to the oysters, and besides, in most cases the neighboring bays are also densely crowded with oysters, so there can be no help from that source. Except in the deeper bayous where the currents are exceptionally strong, there is not enough food material in the water to allow of the stocking of nearly the entire bottom, if it is expected to grow oysters to maturity on the same bottom on which the clutch was exposed. In this regard, it is seen also that the larger bodies of water offer the best conditions for the growth of oysters, since there is always a large percentage of the bottom that will be barren of oysters and capable of furnishing a supply of food organisms which will be carried about by the currents and thus made available to the oysters on the areas that are incapable of furnishing the food necessary for their rapid growth.

FOOD AND SALINITY TABLE.

In making the table showing the results of the determinations of the food value of the water and the amount available for each oyster, the general average of all the determinations made in each locality has alone been given. All the determinations were made at practically the same time in the year, so that the publication of all the figures, or of monthly averages, would have no value toward showing seasonal variations in the food supply.

GULF BIOLOGIC STATION, Nov. 6, 1907.

PLACE	Average Salinity.	Diatoms in One Litre of Water.	Diatoms in Stomach of One Oyster.
Bay Junup.....	1.009	17,786	12,984
Mud Hole Bay.....	1.014	18,895	15,555
Taylor's Bayou.....	1.0126	20,440	17,388
King Lake.....	1.0094	19,998	17,247
Sister Lake.....	1.0115	18,996	14,468
Bayou Grand Caillou.....	1.0128	19,784	16,874
Grand Pass des Isles.....	1.0158	18,426	15,587
Bay Wilson.....	1.0157	17,984	14,297
Pelican Lake.....	1.016	16,887	14,721
Bayou Salé.....	1.0162	18,996	16,662
Bay Saint Helene.....	1.0186	16,785	15,347
Oyster Bay.....	1.0158	17,342	12,484
Bay Crocodile.....	1.014	16,535	14,728
Bay Jacko.....	1.012	17,459	15,582
Terrebonne Bayou.....	1.0128	18,717	14,444
Bay Jean Pierre.....	1.016	19,666	17,664
Bay Jacko Pass.....	1.0158	16,728
Mud Bayou.....	1.0124	15,583	15,797
Bayou La Peur.....	1.0124	17,888	12,187
Lake Felicity.....	1.0153	14,477	12,998
Lake Little.....	1.0158	15,199	14,777
Upper Timbalier Bay.....	1.0164	17,842	16,333

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